UNIVERSITI TEKNOLOGI MARA

CONTROLLED RECTIFIER USING SINGLE-PHASE MATRIX CONVERTER

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CANDIDATE'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the result of my own work, unless otherwise indicated or acknowledged as referenced work. This topic has not been submitted to any other academic institution or non institution for any other degree or qualification.

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ABSTRACT

In this work basic investigations are carried out on the operation of a proposed single-phase AC-DC converter using single-phase matrix converter (SPMC) topology. Two different categories of operation, namely; a) AC-DC converter including safe commutation strategies to avoid generation of damaging voltage spikes, and b) with input LC filter. This is then extended to operate the SPMC as an advanced AC-DC converter with boost rectifier operation feeding a RC load subjected to active power filter function. The power circuit uses a pair of back-to-back IGBT with diode in series arranged in common emitter mode to realize its required bi-directional operation. Open-loop control was realised using the Pulse Width Modulation (PWM) technique implemented using Peripheral Interface Controller (PIC) at the heart of its control electronics. Basic resistor and inductor loads are used during operation to ascertain the behaviour. A closed-loop control using standard proportional integral control was used to implement active power filter functions to correct the pulsating nature of the input current to almost unity power factor form with low total harmonic distortion (THD) level well below the acceptable limit that was defined in the standards of IEEE 519-1992. This was implemented using both the analogue and digital techniques of control. Waveshaping is facilitated through the use of boost technique that could perform corrections making it continuous, sinusoidal and in phase with the supply voltage. Prior to its practical realization a computer simulation model is developed to investigate the behaviour of the SPMC using MATLAB/Simulink (MLS) incorporating SimPowerSystem and Pspice circuit simulations. An experimental test-rig was then constructed to verify the operation; incorporated with control electronics, gate drives, and power circuits. It is presented that the proposed AC-DC converter using SPMC had been theoretically developed, conceived and successfully realised complete with active power filter function.

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CHAPTER ONE

INTRODUCTION

1.0 Introduction

Development of semiconductor devices and microprocessor technology during the last thirty years has changed rapidly power electronics technology and the number of application has been on the increase. A typical power electronic system is normally used as an interface between the load and the supply comprising a power converter, a load/source and a control unit. The general classifications of converters on functional basis are:

- AC-AC conversion
- AC-DC conversion (rectifier)
- DC-DC conversion
- DC-AC conversion (inverter)

Among all of these types of electrical power conversion, the AC-DC (rectifier) is by far the largest group of power switching circuits applied in industrial applications. This type of converter is widely used in adjustable-speed drives (ASDs), switch-mode power supplies (SMPSs), uninterrupted power supplies (UPS) and utility interface with non-conventional energy sources such as solar PV and battery energy storage systems (BESSs) etc. They have also found applications in process technology such as electroplating, welding units and battery charging for electric vehicles. Other applications also includes but not limited to various power supply technologies for communication systems, measurement and test equipments.

Conventionally, the rectifier topologies are developed using diodes and thyristors to provide uncontrolled and controlled dc power with unidirectional and bidirectional power flow. However, they have demerits of poor power quality due to injected